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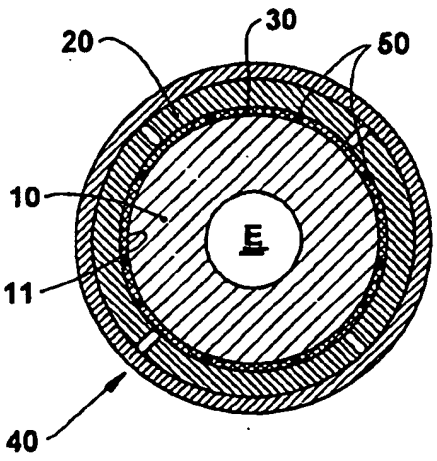
(54) Title: AN ELECTRIC MOTOR ROTOR AND A PROCESS FOR PRODUCING AN ELECTRIC MOTOR ROTOR

(57) Abstract

An electric motor rotor and a process for producing an electric motor rotor, comprising a rotor core (10) in which lateral face (11) are seated and affixed, through a retaining layer (30) of an adhesive material, magnet elements (20). The adhesive material should have a modulus of elasticity which is lower than the modulus of elasticity of any of the parts of rotor core (10) and magnet elements (20). Around the magnet elements (20) may be provided a rotor cover (40) in a thermo–retractible material which may further surround, through end annular flanges (41), the end faces of the magnet elements (20) and also the end annular faces (12) of the rotor core (10). Spacing means (50) may be provided at the region of the retaining layer (30), in order to guarantee a minimum thickness to the latter and, together with the characteristics of the adhesive material, allow to absorb deformations of thermal origin resulting from the operation of the electric motor.



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AN ELECTRIC MOTOR ROTOR AND A PROCESS FOR PRODUCING AN ELECTRIC MOTOR ROTOR

Field of the Invention

The present invention refers to an electric motor rotor and to a process for producing an electric motor rotor of the type used in a hermetic compressor for refrigeration systems and comprising a plurality of magnets placed around the rotor core and usually surrounded by a cover.

Background of the Invention

The electric motor rotor with permanent magnets comprises magnets, which are concentrically mounted to the rotor core and around the motor shaft, said magnets being retained in this condition in order to avoid radial and circumferencial displacements in relation to each other and to the rotor core during the operation of the motor, when the magnets are submitted to centrifugal forces, which tend to separate them from the rotor core, and to shearing forces, which cause the circumferential displacement of said magnets around the core.

There are several known techniques which are used to retain the magnets to the rotor core. In one of said techniques, the magnets are inserted in windows which are stamped in the rotor core. Although being easy to carry out and producing a highly reliable product, this technique has the deficiency of causing energetic losses which may be incompatible with the application intended to the rotor.

In another known technique, the magnets are affixed to the rotor core by gluing. Besides allowing the magnets to be easily affixed to the rotor core, this technique further allows maximum electrical efficiency to be obtained from the motor. However, the product thus

obtained is not very reliable, due to the weak attachment of the magnets to the rotor core, to the centrifugal forces to which they are submitted during the operation of the motor and to the high thermal stresses imparted to the parts, resulting from the different deformations of the materials used.

Besides these solutions, other known techniques are used, in which the magnets are retained through the provision of a rotor cover surrounding the magnets mounted to the rotor core. In one of these techniques, the magnets are pressed onto the rotor core by a metallic cover. Although resulting in a highly reliable product, this technique has the disadvantages of being carried out with more difficulty as compared to the already discussed techniques and of causing high energetic losses.

In another technique for retaining the magnets to the rotor core using an external cover, the latter is coiled with a compound material around the rotor core-magnet assembly. This technique of retaining the magnets to the rotor core is highly reliable and has a good electrical efficiency. However, this solution is very complex to be achieved.

In spite of the advantages obtained, the techniques of retaining the magnets to the rotor core, with medium or high degree of complexity, usually result in high cost products or processes, which are only acceptable to certain products of small scale production. On the other hand, the easily carried out techniques are only justifiable for obtaining products with a short useful life.

Disclosure of the Invention

Thus, it is an objective of the present invention to provide an electric motor rotor and a process for producing an electric motor rotor, which besides

retaining the magnets close to the rotor core during a long useful life, reduces the risk of magnet fragmentation and is industrially viable.

This and other objectives are achieved by an electric motor rotor, comprising a rotor core having a lateral face and end annular faces; magnet elements provided around the rotor core and retained in position thereon by a retaining layer of adhesive material defined between the rotor core and the magnet elements, said retaining layer being defined so as to have a determined minimum thickness, the adhesive material which forms the retaining layer having a modulus of elasticity which is lower than the modulus of elasticity of any of the parts defined by the rotor core and magnet elements, in order to allow, together with said minimum thickness of the retaining layer, the absorption of the thermal deformations of the parts defined by the rotor core and magnet elements during the operation of the electric motor.

Brief Description of the Drawings

The invention will be described below, with reference to the attached drawings, in which:

Figure 1 illustrates, schematically and respectively, a cross-sectional view and a longitudinal diametrical sectional view of an electric motor rotor constructed according to a first embodiment of the present invention;

Figures 2 and 2a illustrate, schematically and respectively, an upper plan view and a longitudinal diametrical sectional view of an electric motor rotor constructed according to a second embodiment of the present invention; and

Figures 3 and 3a are similar views to those of figures 2 and 2a, but illustrating an electric motor rotor constructed according to a third embodiment of the

present invention

Best Mode of Carrying Out the Invention

The present invention refers to an electric motor rotor of the type comprising a rotor core 10, which is to be mounted and affixed to a motor shaft E, surrounding at least part of the latter, and around which are seated magnet elements 20, usually in the form of arcuate longitudinal plates, which are circumferentially spaced from each other and retained against a lateral face 11 of the rotor core 10, which is further provided with end annular faces 12.

According to the present invention, the magnet elements 20 are retained to the rotor core 10 through a retaining layer 30, which is defined between the rotor core 10 and the magnet elements 20 and occupies at least part of the internal surface of the latter, said retaining layer 30 being in the form of an interface of adhesive material, for example, a curable polymeric material, with a modulus of elasticity which is lower than the modulus of elasticity of the rotor core 10 and of the magnet elements 20, after said retaining layer 30 already provided on the rotor has cured.

The retaining layer 30 should have, after its adhesive material has cured, a determined minimum thickness, which is pre-established so as to act as a pad for the magnet elements 20, upon said magnets being pressed against the rotor core 10 by action of a rotor cover 40, to be described hereinafter, which absorbs thermal deformations from both the rotor core 10 and magnet elements 20 associated with the temperature variations of the rotor, upon operation of the electric motor and with the different coefficients of dilatation of the materials (steel which forms the rotor core and magnet elements) which are bonded together by the retaining

layer 30.

The adhesive material used for obtaining the retaining layer 30 is defined in order to produce a retention degree of the magnet elements 20 in relation to the rotor core 10 which may be maintained substantially unaltered under conditions of centrifugal forces and rotational forces (torque) existing during the operation of the motor.

According to the present invention, the adequate thickness of the retaining layer 30 is obtained by maintaining, until the complete cure or until a determined partial cure degree substantially close to the full cure degree of the adhesive material has been achieved, the magnet elements 20 spaced from the rotor core 10 by a pre-established minimum distance, in order to define for the retaining layer 30, after the cure of its adhesive material, a minimum radial spacing between the lateral face 11 of the rotor core 10 and the confronting internal face of the magnet elements 20. The modulus of elasticity of the adhesive material which forms the retaining layer 30 is selected so as to allow that, together with the determination of the minimum thickness of the retaining layer 30, the latter may absorb the thermal deformations existing between the rotor core 10 and magnet elements 20, avoiding the occurrence of high stresses of thermal origin on the magnet elements 20, on the core and on the retaining layer 30 itself.

The rotor of the present invention is produced, by providing positioning means 50 which act on the magnet elements 20, in order to maintain the latter at a predetermined minimum distance from the rotor core 10 to allow the formation of the retaining layer 30, until cure of the adhesive material of the retaining layer 30 is achieved. In a form of carrying out the

present invention, the minimum distance between the magnet elements 20 and the rotor core 10 is obtained by an active process control in real time, which, through the adequate positioning means, retain the magnet elements 20 spaced from the rotor core 10 (without being necessarily located therebetween) for introducing therebetween the adhesive material which will form the retaining layer 30, said positioning condition being thus maintained, until the cure of said retaining layer 30 has ended.

In another form of carrying out the present invention, the positioning means 50 are defined as removable or permanent spacing means, which are provided between the rotor core 10 and the magnet elements 20 and which are designed so as to maintain the minimum radial spacing between the lateral face 11 of the rotor core 10 and the confronting internal face of the magnet elements 20, at least until a determined curing phase of the adhesive material of the retaining layer 30 has been achieved, after which phase the removal of the removable spacing means 50 will not alter said minimal radial spacing of the retaining layer 30.

The positioning means 50 may be removed during the manufacturing process of the rotor, after the curing phase of the adhesive material which forms the retaining layer 30, when the removal of said spacing means affects no more the minimum distance between the magnet elements 20 and the rotor core 10.

In the solution of a retaining layer 30 with permanent spacing means 50, the latter may be provided in an aggregated (or embedded) form to the adhesive material of the retaining layer 30 (figures 1 and 1a), before or during the application of said material to the lateral face 11 of the rotor core 10, or also provided in the form of radial ribs affixed or incorporated in

at least one of the parts of rotor core 10 and magnet elements 20. Said radial ribs (not illustrated) may be provided such as described in copending Patent Application PI9504773-5, of the same applicant.

In the solution in which the spacing means 50 are aggregated to the adhesive material of the retaining layer 30, said spacing means should have a determined modulus of elasticity at maximum substantially equal to that of the retaining layer 30, after the cure of the adhesive material of the latter has been effected, so as not to alter the characteristic of absorbing the thermal deformations of both the rotor core 10 and magnet elements 20, since the provision of spacing means 50 with a high modulus of elasticity would generate regions of thermal stress in the retaining layer 30 and in the magnet elements 20, diminishing their characteristic of absorbing the thermal deformations of said rotor core and magnet elements.

In the solution where the spacing means 50 are aggregated to the adhesive material of the retaining layer 30, said spacing means are defined by a plurality of particulate elements with any shape, for example spherical, such as glass, plastic material, etc., or also in the form of rods, plates or similar elements, with a structural material having said characteristic of modulus of elasticity.

In the solution in which the spacing means 50 are permanent and in the form of radial ribs, the latter should be longitudinally affixed, for example incorporated in at least one of the parts defined by the lateral face 11 of the rotor core 10 and internal face of each magnet element 20, extending along at least part of the axial extension of the respective part to which they are affixed and in order to be provided, in pairs, between each magnet element 20 and

the rotor core 10, symmetrically in relation to the transversal plane of symmetry of the respective magnet element 20, each radial rib being adjacent to an end portion of the corresponding magnet element 20, as described in copending Patent Application PI9504773, of the same applicant.

In an illustrated constructive option, after the rotor core 10 has affixed the magnet elements 20 by action of the adhesive material of the retaining layer 30, this assembly is surrounded, at least laterally, by a tubular cover 40 made of a thermo-retractable material and having a determined radial gap, which is designed in order that, after submitted to a thermal contraction in which it may have its dimensions reduced up to 50% of its original value, the cover exerts a determined compressive radial force on the magnet elements 20 or only over a portion of the adjacent external face of said magnet elements 20, so as to maintain the latter, or part thereof, substantially immobilized in relation to the rotor core 10. In this embodiment (figures 1 and 1a), the rotor cover 40 avoids that chips or any other fragments from the magnet elements 20 resulting from partial disaggregation thereof (due to rotational forces and, if still existing, to residual stresses of thermal origin, or also due to impacts or vibrations caused by transportation, for example) be radially expelled from the rotor to the inside of the motor where said rotor operates. The radial retention of these fragments may be achieved by the provision of end annular caps 60, each being placed adjacently to an end annular face 12 of the rotor core 10, radially extending until it covers the adjacent end edge of the rotor cover 40.

In a constructive option, as illustrated in figures 2-

3a, the rotor cover 40 may have an axial extension which is larger than that of the rotor core 10, in order to form, after being mounted and contracted, a pair of end annular flanges 41, which are radially inwardly turned and each being seated against a respective end face of the pair of end faces of each magnet element 20, and also covering, for instance, at least the adjacent end edge of the retaining layer 30 or, as illustrated in figures 2-3a, covering at least part of the radial extension of the adjacent end annular face 12 of the rotor core 10, providing an axial locking of the rotor cover 40 in relation to the rotor core 10.

In order to carry out the present invention, the rotor cover 40 may have a larger or smaller axial extension, in order to form end flanges with any extension, ranging from zero, when the cover has only a lateral wall, up to the value of maximum extension, covering the end annular faces of the rotor core 10.

In this construction, the rotor cover 40 functions as a sealing element to avoid the radial and axial expel of fragments from the magnet elements 20 and also provides finishing to the end portions of the rotor core 10-magnet elements 20 assembly.

In another constructive variant of the present invention, after the thermocontraction of the rotor cover 40 surrounding the rotor core 10 and magnet elements 20, this assembly receives, adjacently to each end portion, a respective finishing annular cap 60, which is attached to said assembly by adequate means, for example by riveting or screwing, providing the axial locking of the rotor cover 40 to the rotor core 10 and magnet elements 20, protecting the adjacent end edge of said rotor cover 40 and also providing a determined and adequate mechanical

rigidity to the rotor cover 40. The finishing annular cap 60 has, for example, a radial extension which is defined in such a way as to cover at least the adjacent radially internal end edge of the rotor cover 40 and which may be extended up to the adjacent external end edge of said rotor cover 40.

The combination of the retaining layer 30 having the additional function of a pad, together with the rotor cover 40, of simple construction and application, guarantees to the assembly a safe attachment, of long useful life and economically viable. The use of the retaining layer object of the present invention allows the rotor cover 40 to be less massive and consequently of simpler production, as compared to the conventionally used covers (metallic covers, coiled covers, etc.).

CLAIMS

1. An electric motor rotor, comprising: a rotor core (10) having a lateral face (11) and end annular faces (12); magnet elements (20) provided around the rotor core (10) and retained in position thereon by a retaining layer (30) of adhesive material defined between the rotor core (10) and the magnet elements (20), characterized in that said retaining layer (30) is defined so as to have a determined minimum thickness, the adhesive material which forms the retaining layer (30) having a modulus of elasticity which is lower than the modulus of elasticity of any of the parts defined by the rotor core (10) and magnet elements (20), in order to allow, together with said minimum thickness of the retaining layer (30), the absorption of the thermal deformations of the parts defined by the rotor core (10) and magnet elements (20) during the operation of the electric motor.

2. An electric motor rotor, as in claim 1, characterized in that it further comprises spacing means (50) provided between the rotor core (10) and the magnet elements (20), in order to guarantee to the retaining layer (30) the determined minimum thickness.

3. An electric motor rotor, as in claim 2, characterized in that the spacing means (50) are in the form of pairs of radial ribs, which are longitudinally affixed in at least one of the parts defined by the lateral face (11) of the rotor core (10) and the internal face of each magnet element (20) and which extend along at least part of the axial extension of the respective part to which they are affixed, said radial ribs being placed, in pairs, between each magnet element (20) and rotor core (10) and symmetrically in relation to the transversal plane

of symmetry of the respective magnet element (20).

4. An electric motor rotor, as in claim 2, characterized in that the spacing means (50) are permanently provided between the rotor core (10) and the magnet elements (20), in the form of a particulate material embedded in the adhesive material of the retaining layer (30) and have a modulus of elasticity at maximum substantially equal to the modulus of elasticity of the already cured adhesive material.

5. An electric motor rotor, as in claim 1, characterized in that it comprises a rotor cover (40), which is tubular, thermo-retractible and which laterally surrounds the magnet elements (20), with a radial gap in relation to the latter calculated in order that, after the thermo-retraction and during the operation of the motor, said rotor cover (40) imparts a determined compressive radial force at least over the external surface of the magnet elements (20) against the rotor core (10).

6. An electric motor rotor, as in claim 5, characterized in that the rotor cover (40) has end annular flanges (41), which are radially inwardly turned, each of said flanges covering an adjacent end face of the magnet elements (20) and an adjacent end edge of the retaining layer (30).

7. An electric motor rotor, as in claim 6, characterized in that the each end annular flange (41) of the rotor cover (40) further covers the adjacent end annular face (12) of the rotor core (10).

8. An electric motor rotor, as in claim 7, characterized in that it includes a pair of end annular caps (60), each being affixed against a respective end face (12) adjacent to the rotor core (10), in order to cover the adjacent end edge of the rotor cover (40).

9. A process for producing an electric motor rotor, comprising: a rotor core (10) having a lateral face (11) and end annular faces (12); magnet elements (20) provided around the rotor core (10) and retained in position thereon by a retaining layer (30) of a curable adhesive material and defined between the rotor core (10) and the magnet elements (20), characterized in that it comprises the steps of:

a- providing positioning means (50), which maintains the magnet elements (20) with a certain predetermined radial spacing in relation to the rotor core (10);

b- providing the adhesive material at the region which is radially defined between the rotor core (10) and the magnet elements (20); and

c- providing the cure of the adhesive material, in order to produce a retaining layer (30) having a determined minimum thickness, the adhesive material which forms the retaining layer (30) having a modulus of elasticity which is lower than the modulus of elasticity of any of the parts of rotor core (10) and magnet elements (20), in order to allow, together with said minimum thickness of the retaining layer (30), the absorption of thermal deformations of said parts of rotor core (10) and magnet elements (20) during the operation of the electric motor.

10. Process, as in claim 9, characterized in that it comprises the step of maintaining the spacing means (50) between the magnet elements (20) and rotor core (10) at least until achieving a partial cure of the adhesive material which forms the retaining layer (30).

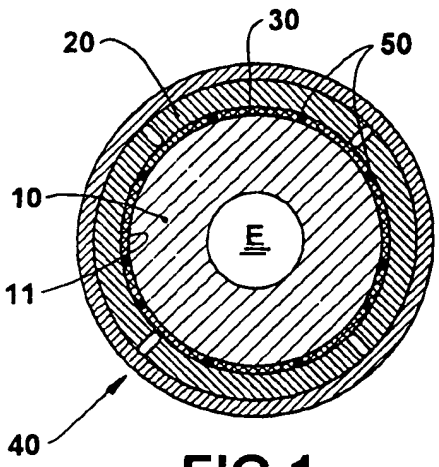

FIG.1

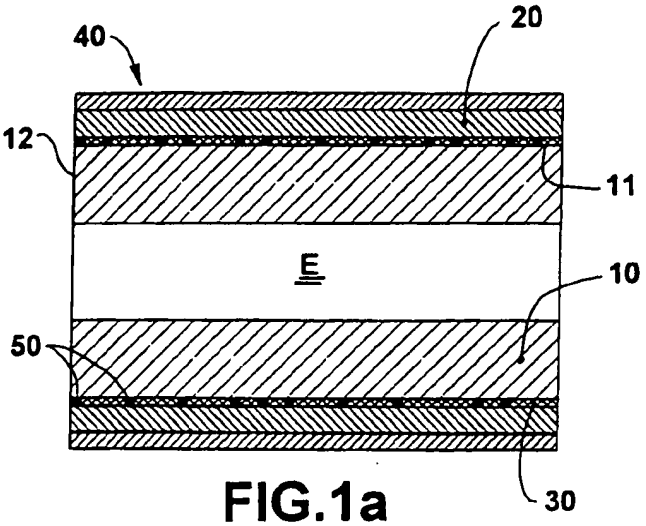

FIG.1a

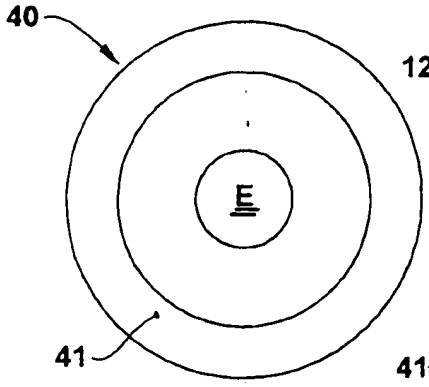

FIG.2

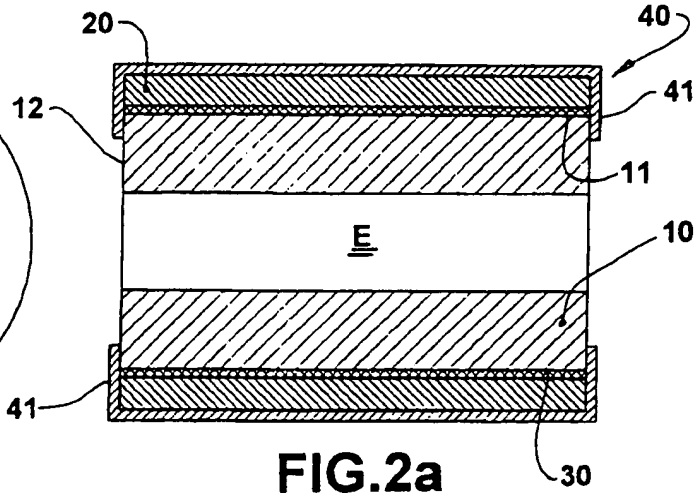

FIG.2a

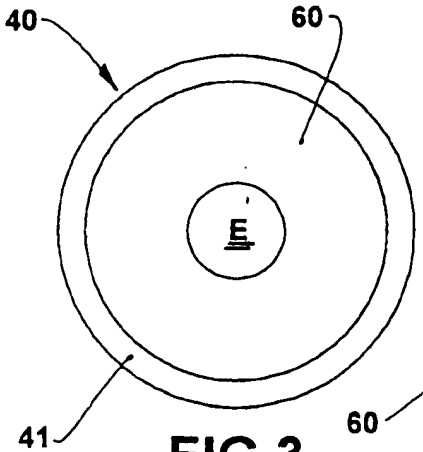

FIG.3

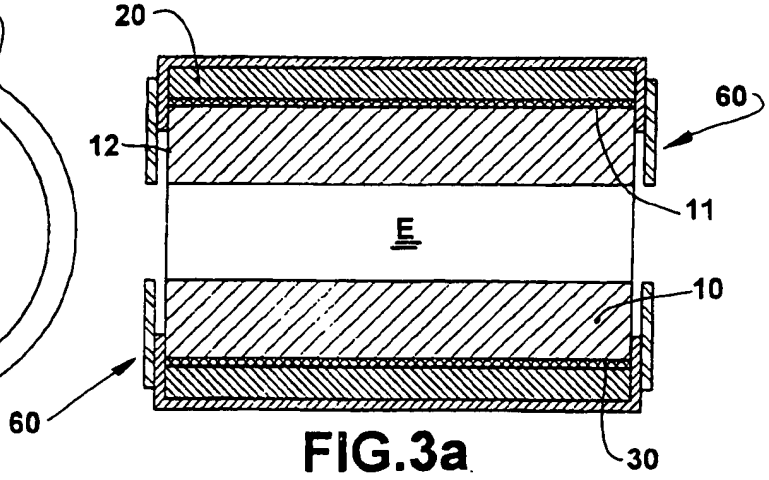

FIG.3a

INTERNATIONAL SEARCH REPORT

In. ational Application No
PCT/BR 98/00078

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H02K15/03 H02K1/27

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 5 734 216 A (YAMADA ET AL.) 31 March 1998 see column 3, line 60 - column 5, line 23; figures	1,9 5
Y	PATENT ABSTRACTS OF JAPAN vol. 9, no. 159 (E-326) '1882!, 4 July 1985 & JP 60 035945 A (YASUKAWA), 23 February 1985 see abstract	5
A	US 5 495 658 A (TESHIGAWARA ET AL.) 5 March 1996 see column 5, line 23 - line 39; figures 9,10	1,5

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 96, no. 6, 28 June 1996 & JP 08 047188 A (DAIDO STEEL), 16 February 1996 see abstract -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

Ir. .ational Application No
PCT/BR 98/00078

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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